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Effect of organics on the growth parameters of bell pepper under shade house condition

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Abstract : A field experiment was conducted to know the effect of organic fertilizers on growth parameters of bell pepper grown in shade house condition. Split plot design with three replications was adopted with two bell pepper varieties *viz*., California Wonder (V_1) and Gangavati Local (V_2) as main plot treatments and nine completely organic nutrient sources along with recommended package of practices nutrients and only recommended inorganic nutrients sources were used as sub plot treatments (O_1 to O_{11}). The two bell pepper varieties did not differ much with respect to growth parameters like plant height, spread and number of branches. With respect to flowering, the performance of California Wonder was superior in terms of days taken from fruit set to harvest (32.98 days). Among the nutrient sources, the FYM (50%) + poultry manure (50%) equilvalent to 100 per cent RDN (basal) treatment was found to be superior with respect to growth parameters *viz*., plant spread (53.06 cm), number of primary branches (2.15), number of secondary branches (6.99) and stem girth (1.22) and the plants under this treatment also took least number of days for fruit set (34.35 days).

Key words : Organics, Bell pepper, Shade house, Vermicompost, Poultry manure FYM

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Bell pepper (*Capsicum annum* var. *grossum*) is one of the highly remunerative vegetables cultivated in most parts of the World. It has attained a status of high value crop in India in recent years and occupies a pride of place among vegetables in Indian cuisine because of its high ascorbic acid and other vitamins and minerals. It also finds a place in preparations like *pizza*, *stuffings* and *burger* with the growing popularity of fast foods. The high market price it fetches is attributed to heavy demand from the urban consumers. There is a good demand for export too. The export market needs fruits with longer shelf life, medium sized tetra lobed fruits with good taste. However, the supply is inadequate due to the low productivity of the crop (Muthukrishnan *et al.,* 1986). Despite its economic importance, growers are not in a position to produce good quality bell pepper with high productivity due to various biotic (pest and diseases), abiotic (rainfall, temperature, relative humidity and light intensity) and crop factors (flower and fruit drop). Due to erratic behavior of weather, the crops grown in open field are often exposed to fluctuating levels of temperature, humidity, wind flow *etc.* which ultimately affect the crop productivity adversely (Ochigbu and Harris, 1989). Besides this, limited availability of land for cultivation hampers the vegetable production. Hence, to obtain a good quality produce and production during off season, there is a need to cultivate bell pepper under protected conditions such as green house, poly house and net house *etc.*

Organic farming of vegetables is most appropriate as most of the vegetables are consumed in the fresh form and pesticidal residues have adverse effect on human health. Capsicum being a high value crop, in the modern capsicum cultivation, with a quest to harvest high yield,

fertilizers and pesticides are being indiscriminately used. Hence, the present study was undertaken to know the response of bell pepper to organic sources of nutrients with respect to its growth parameters under shade house condition.

RESEARCH METHODS

Experimental details:

The experiment was carried out at Agricultural Research Station, Gangavati during 2006 and 2007 in fixed plot which is situated in Northern dry zone of Karnataka (Zone-3) receives rains both from South-West and North-East monsoons and it comes under Tungabhadra command area. The average rainfall received 357.4 mm and 176.4 mm during cropping season (2006 and 2007, respectively). The soil of experimental site was medium block soil and the composite soil samples were collected from 0-25 cm depth before and after the experimentation and samples were subjected for analysis with respect to their physical and chemical properties.

The experiment included main treatments as two bell pepper varieties *viz*., California Wonder and Gangavati Local. Sub treatments were organic source of nutrients *viz*., O_1 : Basal dose application of N equivalent (150 kg/ ha) through FYM 50 per cent and vermicompost 50 per cent, O_2 : Basal dose application of 75 per cent N equivalent through FYM 50 per cent and vermicompost 25 per cent (37.5 kg N /ha) and top dressing after 45 DAT with 25 per cent (37.5 kg N/ha) N equivalent through vermicompost, O_3: Basal dose application of 150 per cent N equivalent (225 kg N) through FYM 50 per cent (112.5 kg N /ha) and vermicompost 50 per cent (112.5 kg N /ha), O_4: Basal dose application of 150 per cent N equivalent(225 kg N/ha) through FYM 50 per cent (112.5 kg N /ha) and vermicompost 25 per cent (56.25 kg N /ha) and top dressing after 45 DAT with 25 per cent (56.25 kg N/ha) N equivalent through vermicompost, O_5: Basal dose applications of N equivalent (150 kg/ha) through FYM 50 per cent and poultry manure 50 per cent, O_6: Basal dose application of 75 per cent N equivalent through FYM 50 per cent and poultry manure 25 per cent (37.5 kg N /ha) and top dressing after 45 DAT with 25 per cent (37.5 kg N/ha) N equivalent through poultry manure, O_7 : Basal dose application of 150 per cent N equivalent (225 kg N) through FYM 50 per cent (112.5 kg N /ha) and poultry manure 50 per cent (112.5 kg N /ha), O_8 : Basal dose application of 150 per cent N equivalent(225 kg N/ha) through FYM 50 per cent (112.5 kg N /ha) and poultry manure 25 per cent (56.25 kg N / ha) and top dressing after 45 DAT with 25 per cent (56.25 kg N/ha) N equivalent through poultry manure, O_9 : Basal dose application of 150 kg RDN equivalent through FYM in addition to 25 tons/hectare recommended FYM, O_{10}: 150:75: 50 kg/ ha through inorganic fertilizer sources and 25 tons/hectare FYM as per the recommended package (Control 1), O_{11} : 150:75:50 kg/hectare through inorganic fertilizer sources only (Control 2). The experiment was laid out in split plot design with three replications.

The composted FYM and vermicompost were produced on the research farm while poultry manure were purchased outside. The experimental area was sown with sunhemp (*Crotolaria junicia*) about three months before and the crop was incorporated in to the soil 45 days before the transplanting of bell pepper. The sunhemp incorporation was taken up in all the experimental plots except in the sub plot treatments O_{10} and O_{11}. Later, the plot area was brought to fine tilth by repeated ploughing and harrowing.

The nursery area was ploughed, harrowed and the soil was brought to a fine tilth. The weed free nursery beds of 10 m length, 1 m width with 15 cm height were prepared. While preparation of beds, clear demarcation was made for organic beds and inorganic beds for raising seedlings as per the treatment requirement of the experiments. The beds for raising nursery seedlings for organic nutrient sources treatment were prepared by incorporating well decomposed FYM +sand + red soils. The beds meant for raising seedlings required for inorganic treatments (O_{10} and O_{11}) were incorporated with recommended dose of inorganic fertilizer mixture along with FYM before sowing of the bell pepper seeds. To avoid seed and soil borne diseases the bell pepper seeds were treated with *Trichoderma viridae* before sowing.

Thirty five days age old bell pepper seedlings were transplanting geometry of 60 cm x 45 cm in the Galvanized steel pipe framed structure, 30m length (East-West) and 25 m breadth (North –South) covered with perforated green nylon net which had capacity to allow only 50 per cent of light inside. The roots of the seedlings (except seedling meant for O_{10} and O_{11} treatment) were dipped in the slurry containing biofertilizers *viz*., *Azospirillum*, mycorhizial and phosphorus soluberizing bacterial cultures for ten minutes.

All necessary care and cultural operations were under taken to raise bell pepper crop. However, while diseases and pest were managed by use of only animal or plant origin products (neem oil, NSKE 0.5 per cent, NPV, *Pseudomonas florescence*, *Nomuruea releyi, Trichoderma viridae*, *Hirestela thampane*, *Verticillium lecani)* in organic plots.

Observation of growth parameters:

Five randomly selected plants were tagged in each treatment plot for recording growth parameters and the mean of the observations on these five plants was computed and recorded.

The height of the plants was measured in centimeters from the ground level to the tip of the main shoot at 30, 60 and 90 days of planting (DAP). The girth of the main stem of the plant was measured in centimeters from 10 cm above the ground level with the help of vernier calipers at 90 DAP and recorded in centimeter. The number of primary branches on the main stem was counted at 90 days after transplanting (DAT) from all tagged plants and mean number of primary branches per plant was recorded. All the branches borne on the primary branches were counted and recorded as number of secondary branches per plant at 90 DAT. The plant spread was recorded in North to South direction at 30, 60 and 90 DAP and expressed as plant spread in centimeter. Number of days taken from the date of transplanting to first flower opening were counted and recorded as days taken to flowering. The number of days taken from the date of transplanting to the flowering of 50 per cent of the tagged plants was counted and recorded.

Statistical analysis and interpretation of the data:

Data generated from the experiments with respect to various parameters were statistically analyzed and interpreted by following Fishers method of analysis of variance as suggested by Panse and Sukhatme (1989). The level of significance used in 'F' and t-test were P=0.05. Critical differences were calculated wherever the 'F' test was found significant.

RESEARCH FINDINGS AND DISCUSSION

The results reveal that (Tables 1-4) the two bell pepper varieties did not differ much with respect to growth parameters like plant height, spread and number of branches. However, with respect to flowering, the performance of California Wonder was superior in terms of days taken from fruit set to harvest (32.98 days).

Among the nutrient sources, the O_5 treatment was found to be superior with respect to growth parameters *viz.*, plant spread (53.06 cm), number of primary branches (2.15), number of secondary branches (6.99) and stem girth (1.22). The plants under this treatment also took least number of days for fruit set (34.35 days). The next best treatment was O_1.

Among the various treatment combinations (varieties

Table 1 : Effect of nutrient sources on plant height (cm) in bell pepper varieties grown under shade house condition (Pooled data)

Nutrient sources	Plant height (cm)								
	30 DAP			60 DAP			90 DAP		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
O_1	48.72	60.13	54.43	70.13	77.40	73.77	88.64	97.67	93.15
O_2	49.18	55.16	52.17	70.91	76.65	73.78	88.48	98.82	93.64
O_3	46.73	58.00	52.36	73.01	74.82	73.92	84.74	95.81	90.27
O_4	46.66	55.30	50.98	70.27	76.66	73.46	84.08	95.26	89.67
O_5	56.24	57.56	56.90	73.31	79.06	76.19	90.20	90.69	90.44
O_6	50.56	56.20	53.38	70.77	77.95	74.36	89.16	99.50	94.33
O_7	48.13	56.23	52.18	75.42	74.90	75.16	86.53	98.32	92.42
O_8	47.41	53.66	50.54	74.97	75.55	75.26	85.54	96.57	91.05
O_9	50.08	55.26	52.67	72.03	75.53	73.78	83.42	93.83	88.62
O_{10}	45.63	53.26	49.45	65.47	74.18	69.83	79.68	93.27	86.47
O_{11}	42.69	49.30	45.99	62.23	71.73	66.98	74.67	92.64	83.65
Mean	48.36	55.46	51.91	70.77	75.86	73.32	85.01	95.67	90.34
	S.E.±	C.D. (P=0.05)		S.E.±	C.D. (P=0.05)		S.E.±	C.D. (P=0.05)	
Varieties (A)	0.473	2.88		0.321	1.96		0.350	2.13	
Nutrients (B)	1.480	4.10		1.071	2.97		0.399	3.87	
A × B	2.094	5.80		1.515	4.20		0.979	5.48	
A × B		4.26			3.23			3.89	

O_1- FYM (50%) + VC (50%) equivalent 100% RDN (basal)
O_2- FYM (50%) + VC (50%) equivalent 100% RDN (25% VC top dressing)
O_3- FYM (50%) + VC (50%) equivalent 150% RDN (basal)
O_4- FYM (50%) + VC (50%) equivalent 150% RDN (25% VC top dressing)
O_5- FYM (50%) + PM (50%) equivalent 100% RDN (basal)
O_6- FYM (50%) + PM (50%) equivalent 100% RDN (25% PM top dressing)
O_7- FYM (50%) + PM (50%) equivalent 150% RDN (basal)
O_8- FYM (50%) + PM (50%) equivalent 150% RDN (25% PM top dressing)
O_9- FYM (100 % equivalent to RDN) + 25 ton FYM
O_{10}- 100% RDF + 25 tons FYM
O_{11}-100 % RDF
V_1 : California Wonder V_2- Local DAP- Days after planting

Table 2 :Effect of nutrient sources on plant spread (cm) in bell pepper varieties grown under shade house condition (Pooled data)

Nutrient sources	Plant height (cm)								
	30 DAP			60 DAP			90 DAP		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
O_1	32.66	37.21	34.93	47.80	51.84	49.82	48.61	54.16	51.39
O_2	31.77	36.89	34.33	46.72	52.93	49.82	48.73	54.24	51.49
O_3	31.95	36.06	34.00	45.59	49.42	47.51	47.16	52.20	49.68
O_4	31.43	35.98	33.70	46.87	47.45	47.16	47.05	52.12	49.58
O_5	35.24	35.78	35.51	48.49	51.35	49.92	48.78	57.34	53.06
O_6	32.83	34.16	33.49	47.77	48.17	47.97	48.88	53.85	51.37
O_7	33.61	36.95	35.28	46.68	46.65	46.67	49.17	54.01	51.59
O_8	33.05	33.58	33.31	47.21	47.51	47.36	48.42	53.92	51.17
O_9	33.61	32.43	33.02	46.01	47.85	46.93	46.16	52.06	49.11
O_{10}	34.05	36.13	35.09	45.04	47.05	46.04	44.48	51.03	47.75
O_{11}	29.94	33.80	31.87	44.65	46.28	45.46	44.13	50.84	47.49
Mean	32.74	35.36	34.05	46.62	48.77	47.70	47.41	53.25	50.33
	S.E.±	C.D. (P=0.05)		S.E.±	C.D. (P=0.05)		S.E.±	C.D. (P=0.05)	
Varieties (A)	0.714	NS		0.495	NS		0.846	5.15	
Nutrients (B)	1.233	3.41		0.963	2.67		1.236	3.42	
A × B	1.744	4.83		1.362	3.77		1.749	4.84	
A × B		4.20			3.12			4.56	

O_1- FYM (50%) + VC (50%) equivalent 100% RDN (basal)
O_2- FYM (50%) + VC (50%) equivalent 100% RDN (25% VC top dressing)
O_3- FYM (50%) + VC (50%) equivalent 150% RDN (basal)
O_4- FYM (50%) + VC (50%) equivalent 150% RDN (25% VC top dressing)
O_5- FYM (50%) + PM (50%) equivalent 100% RDN (basal)
O_6- FYM (50%) + PM (50%) equivalent 100% RDN (25% PM top dressing)
O_7- FYM (50%) + PM (50%) equivalent 150% RDN (basal)
O_8- FYM (50%) + PM (50%) equivalent 150% RDN (25% PM top dressing)
O_9- FYM (100 % equivalent to RDN) + 25 ton FYM
O_{10}- 100% RDF + 25 tons FYM
O_{11}-100 % RDF
V_1 : California Wonder V_2- Local DAP- Days after planting

Table 3 : Effect of nutrient sources on plant growth parameters of bell pepper varieties grown under shade house condition at 90 days after planting (Pooled data)

Nutrient sources	Plant height (cm)								
	30 DAP			60 DAP			90 DAP		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
O_1	2.29	1.65	1.97	7.37	6.21	6.79	1.2	1.14	1.17
O_2	2.35	1.75	2.05	7.43	6.27	6.85	1.2	1.16	1.18
O_3	1.95	1.45	1.7	7.27	5.89	6.58	1.17	1.13	1.15
O_4	1.86	1.41	1.63	7.27	5.75	6.51	1.16	1.13	1.14
O_5	2.51	1.8	2.15	7.54	6.44	6.99	1.22	1.22	1.22
O_6	2.43	1.79	2.11	7.49	6.35	6.92	1.19	1.2	1.19
O_7	2.23	1.54	1.88	7.32	6.18	6.75	1.18	1.17	1.17
O_8	2.06	1.5	1.78	7.28	6.13	6.705	1.19	1.12	1.15
O_9	1.76	1.37	1.56	6.88	5.51	6.19	1.18	1.09	1.13
O_{10}	1.63	1.26	1.44	6.61	5.48	6.04	1.03	0.9	0.96
O_{11}	1.53	1.17	1.35	6.53	5.34	5.93	0.97	0.87	0.92
Mean	2.05	1.51	1.78	7.18	5.95	6.57	1.15	1.1	1.12
	S.E.±	C.D. (P=0.05)		S.E.±	C.D. (P=0.05)		S.E.±	C.D. (P=0.05)	
Varieties (A)	0.004	0.03		0.293	NS		0.002	0.01	
Nutrients (B)	0.013	0.03		0.634	NS		0.009	0.02	
A × B	0.018	0.05		0.897	NS		0.013	0.02	
A × B		0.04			NS			0.02	

O_1- FYM (50%) + VC (50%) equivalent 100% RDN (basal)
O_2- FYM (50%) + VC (50%) equivalent 100% RDN (25% VC top dressing)
O_3- FYM (50%) + VC (50%) equivalent 150% RDN (basal)
O_4- FYM (50%) + VC (50%) equivalent 150% RDN (25% VC top dressing)
O_5- FYM (50%) + PM (50%) equivalent 100% RDN (basal)
O_6- FYM (50%) + PM (50%) equivalent 100% RDN (25% PM top dressing)
O_7- FYM (50%) + PM (50%) equivalent 150% RDN (basal)
O_8- FYM (50%) + PM (50%) equivalent 150% RDN (25% PM top dressing)
O_9- FYM (100 % equivalent to RDN) + 25 ton FYM
O_{10}- 100% RDF + 25 tons FYM
O_{11}-100 % RDF
V_1 : California Wonder V_2- Local DAP- Days after planting

Table 4 : Effect of nutrient sources on days to flowering, 50% flowering and days to harvest from fruit set of bell pepper varieties grown under shade house condition (Pooled data)

Nutrient sources	Plant height (cm)								
	30 DAP			60 DAP			90 DAP		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
O_1	29.67	33.29	31.48	43.01	48.70	45.85	32.65	36.99	34.82
O_2	30.05	33.78	31.91	42.85	46.77	44.81	32.41	38.55	35.48
O_3	29.8	33.99	31.89	43.45	48.68	46.06	33.23	38.56	35.89
O_4	29.08	31.37	30.22	43.43	48.85	46.14	33.35	38.6	35.97
O_5	28.19	34.58	31.38	40.65	45.84	43.24	31.08	37.62	34.35
O_6	29.06	32.85	30.95	41.04	48.00	44.52	32.00	37.16	34.58
O_7	27.22	33.36	30.29	42.98	48.85	45.91	32.48	38.48	35.48
O_8	30.18	33.51	31.84	43.37	48.46	45.91	33.09	38.43	35.76
O_9	29.68	31.59	30.63	43.54	49.43	46.48	34.23	38.53	36.38
O_{10}	29.99	30.88	30.43	43.55	49.73	46.64	34.3	39.18	36.74
O_{11}	31.97	32.58	32.27	44.77	49.95	47.36	34.03	38.98	36.5
Mean	29.5	32.88	31.21	42.96	48.47	45.72	32.98	38.28	35.63
	S.E.±	C.D. (P=0.05)		S.E.±	C.D. (P=0.05)		S.E.±	C.D. (P=0.05)	
Varieties (A)	0.574	NS		0.650	3.96		0.058	0.35	
Nutrients (B)	1.213	NS		1.429	3.96		0.147	0.40	
A × B	1.717	4.76		2.022	5.60		0.208	0.57	
A × B		3.83			4.45			0.44	

O_1- FYM (50%) + VC (50%) equivalent 100% RDN (basal)
O_2- FYM (50%) + VC (50%) equivalent 100% RDN (25% VC top dressing)
O_3- FYM (50%) + VC (50%) equivalent 150% RDN (basal)
O_4- FYM (50%) + VC (50%) equivalent 150% RDN (25% VC top dressing)
O_5- FYM (50%) + PM (50%) equivalent 100% RDN (basal)
O_6- FYM (50%) + PM (50%) equivalent 100% RDN (25% PM top dressing)
O_7- FYM (50%) + PM (50%) equivalent 150% RDN (basal)
O_8- FYM (50%) + PM (50%) equivalent 150% RDN (25% PM top dressing)
O_9- FYM (100 % equivalent to RDN) + 25 ton FYM
O_{10}- 100% RDF + 25 tons FYM
O_{11}-100 % RDF
V_1 : California Wonder V_2- Local DAP- Days after planting NS=Non-significant

x organic source of nutrients), the treatment combinations O_6V_2 and O_2V_2 were recorded maximum growth parameters *viz*., plant height (99.50 cm and 98.82 cm, respectively). The treatment combinations O_5V_2 recorded maximum plant spread of 57.34 cm. The treatment combinations O_5V_1 was found to be superior with respect to growth parameters *viz*., number of primary branches (2.51), number of secondary branches (7.54) and stem girth (1.22).

Plant nutrients supplied through organic sources had profound effect on growth and productivity of the crop either by acceleration of respiratory process with increasing cell permeability and hormonal growth action or by combination of all these processes. Through their biological decomposition processes the organic sources supply nutrients to the plants in the available form. They are also rich in micro nutrients besides having plant growth promoting substances *viz*., hormones, enzymes and humus forming beneficial microbes. Organic sources, on application to the soil, improve the physical properties of soil such as aggregation, aeration, permeability and water holding capacity (Govindarajan and Thangaraju, 2001) which promote growth and development of plants. It has been reported that among the organic sources of nutrients, poultry manure proved to be the best source of organic manure which helped in improving physico-chemical properties (pH, EC, organic carbon, macro and micro nutrients) of soil because of its higher analytical values (Jeyabaskaran *et al*., 2001 and Naidu *et al.,* 2002). It contained 2.00, 1.97, 4.92 per cent NPK, respectively and 113.2, 71.0, 140.6 and 310.5 mg/kg of total zinc, copper, iron and manganese, respectively (Gopal Reddy, 1997). It has also been experimentally proved that considerable amount of N present in poultry manure consist of uric acid, which is readily available to the plants. The C: N ratio of poultry manure reported to be narrower than FYM, which attenuates the release of nitrogen (Chadwick *et al.,* 2000).

Vermicompost is known to be another good organic sources of nutrient which had showed better results because of its higher macro (NPK @ 1.2:0.86 : 0.80 %) and micro nutrients, growth hormones, vitamins, antibiotics, enzymes, humic acid, beneficial microbes etc., which have better effect on growth of plants (Anitha *et*

al., 2003). Vermicompost, besides being rich source of macro and micro nutrients, it also acts as a chelating agent and regulates the plants by providing nutrients in the available forms. It also contains large quantities of beneficial microbial population and biologically active metabolites, particularly gibberlins, cytokinins, auxins and group B vitamins.

The increased growth due to the application of FYM + poultry manure combinations may be attributed to their influence on improving physico- chemical properties (pH, EC, organic carbon, macro and micro nutrients) of soil (Jeyabaskaran *et al*., 2001 and Naidu *et al.,* 2002) favouring the rhizosphere more congenial for nutrient uptake and utilization. Further, considerable amount of nitrogen present in poultry manure consist of uric acid which was readily available to the plant helping them in good growth right from the beginning of the crop.

The better growth parameters from shade house condition might be due to the congenial growing environment which prevailed inside the shade house that helped the plant in better utilization of solar radiation and nutrients for the production of photosynthates and transformation of metabolites in to economic parts like fruits. Further, the moderate temperature in combination with higher relative humidity prevailing inside the shade house might have helped in fast multiplication of cells and cellular elongation resulting in a better growth of roots, shoots, number of branches and leaf area which directly helped in a better vegetative growth.

Conclusion:

The effect of organic sources has profound effect on growth parameters of bell pepper varieties grown in shade house. The treatment combination *i.e*., basal dose applications of N equivalent (150 kg/ha) through FYM 50 per cent and poultry manure 50 per cent in the variety California Wonder had significant response to growth parameters like plant height, plant spread and number of secondary branches.

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